Development of Statewide Nutrient Standards Impacts to Wastewater Treatment

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EPA Mandate

- 1996 – states must adopt numeric nutrient criteria for surface waters
- Narrative standards do not adequately identify or protect problem waterbodies
- Nutrient pollution causes harmful algal blooms
  - Toxic algal events
  - Depleted dissolved oxygen
- Required a “Nutrient Criteria Development Work Plan”

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Work Plan

- Reservoirs
  - June 2010 TCEQ adopted criteria for chlorophyll *a* for 75 reservoirs
  - July 2013 EPA Review
    - Approved 39 reservoirs
    - Disapproved 36 reservoirs
- Streams – In progress
- Triennial Standards Review will only include revision to nutrient work plan
  - No new nutrient criteria will be proposed
- Additional criteria may be considered around the 2016-2017 calendar years

Area Reservoir Chlorophyll a Criteria

Reservoir	**Chlorophyll *a* Criteria** (µg/L)	**FY 2014 Water Quality Assessment Chlorophyll *a* Median** (µg/L)
Stillhouse Hollow	5.00	4.10
Lake Belton	6.38	7.64

Nutrient Concerns in Area Streams from 2012 Texas Water Quality Inventory

Segment	Stream	Nutrient Concerns
1215	Lampasas River Below Stillhouse Hollow	none
1217	Lampasas River Above Stillhouse Hollow	none
1218	Nolan Creek/South Nolan Creek	Nitrate, Orthophosphorus,Total Phosphorus
1219	Leon River Below Belton	Nitrate, Orthophosphorus
1221	Leon River Above Belton	Chlorophyll a

Implementation Plan

- **Draft 2012 IP Plan available at: http://www.tceq.texas.gov/assets/public/permitting/waterquality/standards/docs/2011draft-impprocedures.pdf**
- **Defines procedures used by TCEQ to apply water quality standards to TPDES permit**
- **Procedures based on location of discharge**
  - **Reservoir**
  - **Surface water**

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Nutrient Standard Applicability

- New or expanding domestic discharges
  - All will be evaluated for total phosphorus (TP) and total nitrogen (TN)
  - Will receive effluent limit if warranted
- Industrial Discharges
  - Evaluation depends on operation
  - May be subject to limitations on TP and/or TN

Initial Assessment

- General Guidelines
- Comprehensive, site-specific screening
  - Very detailed
  - Multi-step

Initial Assessment-Reservoirs

- Generally focusing on TP limits
- Main Body or Near Reservoir
  - New/expanding discharges ≥1 MGD
- Shallow or Restricted Coves
  - New/expanding discharges ≥0.25 MGD
- Watershed rules or other specific regulatory requirements (TMDL, 305b)
- Smaller discharges will be evaluated if discharge is into a sensitive area.

Initial Assessment - Streams

- Generally focusing on TP limits
- New/expanding discharges ≥0.25 MG
  - Perennial, shallow, clear streams with rocky bottoms
  - Long, shallow, clear streams with perennial impoundments
- Watershed rules or other specific regulatory requirements (TMDL, 305b)
- Smaller discharges will be evaluated if discharge is into a sensitive area.

Typical TP Effluent Limits

Permitted Flow (MGD)	TP Limit (mg/L)
<0.5	1.0
0.5-3.0	1.0 to 0.5
>3.0	0.5

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Determining What it Means to Individual Dischargers

- Impact highly variable
- New versus retrofit
- Download IP Plan and perform evaluation to determining likelihood of receiving a standard in your permit
- Current Level and Type of Treatment
  - Nitrification
  - Denitrification
- Level of Removal Needed
  - Need to determine current TP loading

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When Will Nutrient Criteria Impact Permits

- Not sure
- Nutrient limits and/or monitoring requirements in some permits already
- Expect more during this round of permitting
- Do not have indication on how quickly TCEQ expects plants to meet requirements
- Variances – EPA proposed regulation 10 years max

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Other Things to Consider

- **Plant capacity restraints**
- **Property restraints**
- **Energy costs**
- **Operational Controls**
  - **Automation**
  - **More staff time**
  - **More staff training**

Biological Nutrient Removal (BNR)

- **Most current facilities remove ammonia**
- **Some also remove nitrate**
- **Very few designed to remove phosphorus**
- **If you can achieve permit limits, BNR seems to be most cost effective**

Nitrogen (N) Removal through BNR

- **Nitrification**
  - **Removes ammonia**
  - **Aerobic conditions**
- **Denitrificaion**
  - **Removes nitrate**
  - **Anoxic conditions**
- **Solids Separation**
  - **Removes particulate organic N**
- **No common removal mechanism for soluble organic nitrogen**

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Phosphorus (P) Removal through BNR

- Removal of TP requires removal of both particulate and soluble P
- Particulate P
  - Solids separation
- Soluble P
  - Phosphate-accumulating organisms
- Must have an anaerobic zone free of dissolved oxygen and nitrate
- May require construction of additional treatment chamber

P Removal through Chemical Precipitation

- **Aluminum and iron coagulants**
- **Lime**
- **Has higher operating costs than BNR**
- **Produces more sludge with more chemicals = increased disposal costs**

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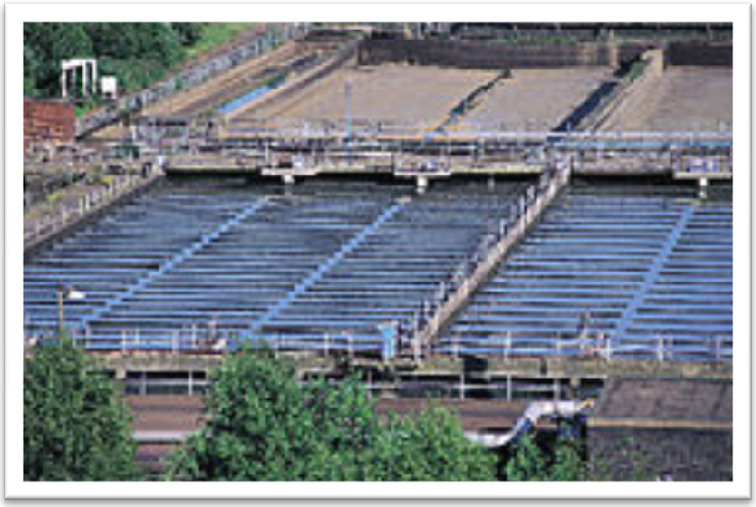
Ultra Low Levels of P

(≈0.1 mg/L)

- May require a combination of BNR and chemical precipitation
- Sand or other filtration may be necessary to remove additional particulate P
- May require advanced treatment



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New Facilities

- More flexibility
- Can be designed to target specified levels of effluent quality

Retrofit

- May be constrained by existing land available and existing treatment units and sludge handling procedures
- Need to Consider
  - Aeration basin size and configuration
  - Clarifier capacity
  - Type of aeration system
  - Sludge processing units
  - Operator skill

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Costs

- New plant costs based on estimated influent quality, target effluent quality and available funding
- Retrofit costs are site-specific and vary considerably
- Costs based on discharge size and limit
  - Larger = more cost effective
  - Smaller limit = more expensive
- Cost increase no longer associated with population growth

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Average Unit Capital Costs for BNR Upgrades

Maryland and Connecticut

Flow (mgd)	Cost/mgd (2006$)
>0.1 – 1.0	$6,972.000
>1.0 – 10.0	$1,742.000
>10.0	$588.00

Montana

Estimated Costs to Reduce TN to 5.0 mg/L and TP to 0.5 mg/L

Cost	Annual Average Cost Flow			
	0.1 MGD	1.0 MGD	10 MGD	30 MGD
Capital	$241,000	$1,112,00	$4,927,000	$12,383,000
O&M	$7,046	$29,218	$157,469	$293,938

Estimated Costs to Reduce TN to 3.0 mg/L and TP to 0.1 mg/L

Cost	Annual Average Cost Flow			
	0.1 MGD	1.0 MGD	10 MGD	30 MGD
Capital	$312,000	$1,268,000	$9,620,000	$26,520,000
O&M	$22,993	$69,925	$311,634	$841,120

Utah

- To remove P to 1.0 mg/L
  - Statewide capital cost to upgrade = $24 million
  - Average monthly bill for residents would increase 7.1% or $1.19/month
  - Costs over 20 years (capital and O&M) = $114 million

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Other Strategies to Consider

- **Treatment wetlands**
  - **Tarrant Regional Water District**
  - **North Texas Municipal Water District**
- **Watershed strategies/coalitions**
- **Reuse/No Discharge**
  - **Lake Travis Water Quality Area**
  - **Lake Austin Water Quality Area**

John Bunker Sands Wetlands – North Texas Municipal Water District

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Estimated Cost of Phosphorus Reduction to 1 mg/L TP at Six WWTPs Discharging to the North Bosque River

City	Permitted Discharge (mgd)	Effluent TP (mg/L)	Capital Cost ($)	O&M Cost ($/yr)	Base Residential Bill ($/mo)	Additional Treatment Cost ($/mo)	Revised Residential Bill ($/mo)	% Increase to Monthly Residential Bill
Stephenville	3.00	2.69	$786,288	$64,413	$20.69	$1.19	$22.88	11%
Clifton	0.65	2.40	$979,000	$14,775	$22.00	$3.77	$25.77	17%
Meridian	0.45	3.36	$2,290,860	$31,191	$18.64	$14.73	$33.37	79%
Hico	0.20	3.52	$825,000	$9,215	$12.00	$7.77	$19.77	65%
Valley Mills	0.36	3.14	$957,000	$20,154	$8.00	$12.02	$20.02	150%
Iredell	0.05	2.96	$792,100	$7,518	$15.14	$25.43	$40.57	168%

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References for Cost Data

- USEPA – Biological Nutrient Removal and Costs http://www.nj.gov/dep/wms/bwqsa/EPA%20-Biologicl%20nutrient%20removal%20processes&costs.pdf
- Montana Department of Environmental Quality – Wastewater Treatment Performance and Cost Data to Support an Affordability Analysis for Water Quality http://www.deq.mt.gov/wqinfo/Standards/default.mcpx
- Utah Division of Water Quality - Statewide Nutrient Removal Cost Impact Study http://www.waterquality.utah.gov/POTWnutrient/
- Keplinger et al. - Cost and Affordibility of Phosphorus Removal at Small Wastewater Treatment Facilities http://www.nesc.wvu.edu/pdf/ww/publications/smallflows/magazine/sfq_fa04.pdf